Claims

What is claimed is:

1. A fuel cell power plant (110, 210, 310, 410) including in combination, a fuel cell stack assembly (CSA)(12) having an anode region (14), a cathode region (16), and an electrolyte region (18) intermediate the anode and cathode regions; a fuel processing system (FPS) including combustion-supported reaction means (20, 120) for receiving a supply of fuel (46, 46′, 48) and an oxidant stream (124, 224, 324, 424) and for providing a hydrogen-rich fuel stream (22) to the anode region (14); a source of oxidant (26); a primary energy recovery device (ERD) (30) having adjacent source (32) and sink (34) channels separated by an enthalpy exchange barrier (36) for the transfer of heat and moisture therebetween; a further energy recovery device (ERD) (50) having means (132, 134, 136) for receiving gas and liquid and flowing at least the gas therethrough in proximity with the liquid for the transfer of heat and moisture therebetween to regulate the dew point of the gas; a source of water (52); at least one of the combustion-supported reaction means (20, 120), the cathode region (16), and the anode region (14) having an exhaust flow (42, 44, 48, 148) for providing an exhaust gas stream (28, 128); and wherein the oxidant source (26) is operatively connected to flow through at least the sink channel of the primary ERD (30) to provide the oxidant stream (124, 224, 324, 424) supplied to at least the combustion-supported reaction means (20, 120), the exhaust gas stream (28, 128) is operatively connected to flow through at least the source channel of the primary ERD (30), the water source (52) is operatively connected to provide the liquid to the further ERD (50), and the further ERD (50) and one of the source

channel (32) and the sink channel(34) of the primary ERD (30) are serially connected (26′, 28′, 126′, 128′)for gas flow therethrough, such that the regulation of the dew point of the gas flowing through the supplemental ERD (50) by the water in the supplemental ERD (50) operates to regulate, at least indirectly, the dew point of the oxidant stream (124, 224, 324, 424) supplied to at least the combustion-supported reaction means (20, 120).

2. The fuel cell power plant (110, 210, 310, 410) of claim **1** wherein the further ERD (50) is upstream of the primary ERD (30) relative to the gas flow therethrough, the exhaust gas stream (28, 128) flows through the further ERD (50), and the regulation of the dew point of the oxidant stream (124, 224, 324, 424) is indirect.

3. The fuel cell power plant (110, 210, 310, 410) of claim **1** wherein the primary ERD (30) is upstream of the further ERD (50) relative to the gas flow therethrough, oxidant from source (26) flows through the further ERD (50), and the regulation of the dew point of the oxidant stream (124, 224, 324, 424) is direct.

4. The fuel cell power plant (110, 210, 310, 410) of claim **1** wherein the oxidant stream (124, 224, 324, 424) applied to the combustion-supported reaction means (20, 120) is also applied, in parallel, to the cathode region (16).

5. The fuel cell power plant (110, 210, 310, 410) of claim **1** wherein the combustion-supported reaction means (20) comprises a catalytic steam reformer (40) and

separate burner (38), and the burner (38) has an exhaust flow (42).

6. The fuel cell power plant (110, 210, 310, 410) of claim **5** wherein the cathode region (16) has an exhaust flow 44, the cathode exhaust gas flow (44) and the burner exhaust flow (42) being combined to form the exhaust gas stream (28).

7. The fuel cell power plant (110, 210, 310, 410) of claim **1** wherein the combustion-supported reaction means (120) comprises a reformer (120) structured for integral combustion therewithin.

8. The fuel cell power plant (110, 210, 310, 410) of claim **7** wherein the reformer (120) is from the group consisting of an autothermal reformer and a catalytic partial oxidizer.

9. The fuel cell power plant (110, 210, 310, 410) of claim **7** wherein the anode exhaust flow (148) comprises a partly-depleted hydrogen gas stream, and the cathode exhaust flow (44) and the anode exhaust flow (148) are combustively reacted in a burner (60) to provide the exhaust gas stream (128).

10. The fuel cell power plant (110, 210, 310, 410) of claim **1** wherein the further ERD (50) comprises adjacent liquid (132) and gas (134) channels separated by an enthalpy exchange barrier (136), the gas flows through the gas channel (134), the water flows through the liquid channel (132), and the transfer of heat and moisture therebetween is via the enthalpy exchange barrier (136).

11. The fuel cell power plant (110, 210, 313, 410) of claim **10** wherein the enthalpy exchange barrier (36, 136) in each of the primary ERD (30) and the further ERD (50) comprises a fine pore saturator medium.

12. The fuel cell power plant (110, 210, 310, 410) of claim **1** wherein the temperature of the water supplied to the further ERD (50) regulates the dew point of the oxidant stream (124, 224, 324, 424) supplied to at least the combustion-supported reaction means (20, 120).

13. A fuel cell power plant (110, 210, 310, 410) including in combination, a fuel cell stack assembly (CSA)(12) having an anode region (14), a cathode region (16), and an electrolyte region (18) intermediate the anode and cathode regions; a fuel processing system (FPS) including combustion-supported reaction means (20, 120) for receiving a supply of fuel (46, 46’, 48) and an oxidant stream (124, 224, 324, 424) and for providing a hydrogen-rich fuel stream (22) to the anode region (14); a source of oxidant (26); a primary energy recovery device (ERD) (30) having adjacent source (32) and sink (34) channels separated by an enthalpy exchange barrier (36) for the transfer of heat and moisture therebetween; a further energy recovery device (ERD) (50) having adjacent liquid (132) and gas (134) channels separated by a fine pore saturator medium enthalpy exchange barrier (36, 136) for the transfer of heat and moisture therebetween to regulate the dew point of the gas flowing in the gas channel (134) as a function of the liquid; a source of water (52); at least one of the combustion-supported reaction means (20, 120), the cathode region (16), and the anode region (14) having an exhaust flow (42, 44, 48, 148) for providing an exhaust gas stream (28, 128); and

wherein the oxidant source (26) is operatively connected to flow through at least the sink channel of the primary ERD (30) to provide the oxidant stream (124, 224, 324, 424) supplied to at least the combustion-supported reaction means (20, 120), the exhaust gas stream (28, 128) is operatively connected to flow through at least the source channel of the primary ERD (30), the water source (52) is operatively connected to flow at a controlled temperature through the liquid channel (132) of the further ERD (50), and the gas channel (134) of the further ERD (50) and one of the source channel (32) and the sink channel(34) of the primary ERD (30) are serially connected (26′, 28′, 126′, 128′)for gas flow therethrough, such that the regulation of the dew point of the gas flowing through the supplemental ERD (50) by the temperature of the water in the supplemental ERD (50) operates to regulate, at least indirectly, the dew point of the oxidant stream (124, 224, 324, 424) supplied to at least the combustion-supported reaction means (20, 120).

14. In a fuel cell power plant (110, 210, 310, 410) including in combination, a fuel cell stack assembly (CSA)(12) having an anode region (14), a cathode region (16), and an electrolyte region (18) intermediate the anode and cathode regions; a fuel processing system (FPS) including combustion-supported reaction means (20, 120) for receiving a supply of fuel (46, 46′, 48) and an oxidant stream (124, 224, 324, 424) and for providing a hydrogen-rich fuel stream (22) to the anode region (14); a source of oxidant (26); a primary energy recovery device (ERD) (30) having adjacent source (32) and sink (34) channels separated by an enthalpy exchange barrier (36) for the transfer of heat and moisture therebetween; at least one of the combustion-

supported reaction means (20, 120), the cathode region (16), and the anode region (14) having an exhaust flow (42, 44, 48, 148) for providing an exhaust gas stream (28, 128), the exhaust gas stream (28, 128) being operatively connected to flow through at least the source channel (32) of the primary ERD (30); and wherein the oxidant source (26) is operatively connected to flow through at least the sink channel (34) of the primary ERD (30) to provide the oxidant stream (124, 224, 324, 424) supplied to at least the combustion-supported reaction means (20, 120), the method of regulating the dew point of the oxidant stream (124, 224, 324, 424) supplied to at least the combustion-supported reaction means (20, 120) comprising the step of:

a) passively condensing (50) moisture from a gas stream (28, 128, 26′, 126′), the gas stream being one or the other of:

i) the oxidant stream (26′, 126′) downstream of the flow of the oxidant source (26) through the sink channel (34) of the primary ERD (30), thereby to effect direct regulation of said dew point; or

ii) the exhaust gas stream (28, 128) upstream of the flow of the exhaust gas stream (28′, 128′) through the source channel (32) of the primary ERD (30), thereby to effect indirect regulation of said dew point.

15. The method of claim **14** wherein the step of passively condensing (50) moisture from a gas stream (28, 128, 26′, 126′) comprises flowing (134) said gas stream in proximity with a liquid (52, 132) in a manner to effect a transfer (136) of heat and moisture between said liquid and gas streams as a function of at least

the temperature of said liquid relative to said gas stream.

16. The method of claim **15** wherein the liquid (52) is water and the temperature of said water is regulated to effect the condensation needed to regulate the dew point of the oxidant stream (124, 224, 324, 424) supplied to at least the combustion-supported reaction means (20, 120).

17. The method of claim **15** wherein the liquid is water (52) and the step of passively condensing moisture from a gas stream comprises flowing (134) the gas stream (28, 128, 26′, 126′) and flowing (132) the water (52) along respectively opposite sides of a porous enthalpy exchange barrier (136) of a supplemental energy recovery device (50) to effect said transfer of heat and moisture.

18. The method of claim **15** wherein the liquid is water (52) and the gas stream from which moisture is passively condensed (50) comprises the exhaust gas stream (28, 128) upstream of the flow of the exhaust gas stream (28′, 128′) through the source channel (32) of the primary ERD (30), thereby to effect indirect regulation of said dew point.